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Decreased Uncorrected Vision After a Period of Distance Fixation with Spectacle Wear

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ABSTRACT

Myopes of low degree commonly report that their vision seems poorer upon removal of their spectacles compared to that after a period without spectacle wear. Notably, this difference in vision can he appreciated after distance fixation. In this paper, we propose and test several alternative hypotheses to explain the phenomenon: an accommodative response to spectacles, sensory adaptation, or altered criteria for blur of psychological origin. We measured visual acuity (VA), refractive error, and lens thickness on 10 subjects with less than 2.00 D of myopia. Testing was performed after two 90-min sessions viewing at distance. At one session, the subjects wore their current spectacle correction and, at the other session, no correction was worn. VA underwent a slight but significant decrease (0.4 of a line) after the session in which spectacles were worn, but no difference in refractive error or lens thickness was found. The change in acuity in the absence of a refractive shift suggests sensory adaptation to blur. However, the demonstrated change in VA appears to be less than that which is subjectively reported; accordingly, psychological input cannot be ruled out.

Key Words: myopia, adaptation, accommodation, spectacle wear, blur

Clinicians commonly encounter patients who believe that wearing spectacles makes their vision worse. The patient may report poorer vision after spectacle removal compared with that achieved fter an extended period without spectacle wear. Such reports are common and have been seized upon by authors such as Bates[1] and MacFadden[2] as evidence that spectacles are harmful to the eyes. Despite these claims, this phenomenon has not been subjected to scientific scrutiny.

It has been demonstrated that a moderate period of nearwork will lead to an increase in accommodative tonus.[3-6] Clearly, this increased tonus has the potential to decrease distance acuity; however, clinical experience also suggests that the occurrence of decreased vision after spectacle wear may follow viewing confined to distant tasks.

The phenomenon may be explained by a number of theories (including the following) which we have categorized as accommodative, sensory adaptation, or psychological in nature. An accommodative response to spectacle wear would involve a measurable increase in myopia immediately after spectacle removal with a corresponding reduction in uncorrected vision. Sensory adaptation would explain the phenomenon where a reduction in uncorrected vision after spectacle wear is present but there is no evidence of a refractive change for this effect. The psychological theory might propose that the patient perceives a decrease in uncorrected vision after spectacle wear although vision is unaffected, suggesting a change in criteria for assessment of blur.

In this study, we examined 10 subjects with low degrees of myopia to test for the existence of a decrease in uncorrected vision after spectacle wear. The mechanism for this phenomenon was investigated by measuring vision, refractive error, and lens thickness after periods of distance fixation with and without spectacle wear.

METHODS

Subjects

Subjects were recruited by advertising within the Victorian College of Optometry. Subject selection was based on the following criteria: best vision spherical refractive correction between -0.25 and -2.00 D, astigmatism and anisometropia of -1.00 D, absence of ocular pathology,. and vision correctable to 6/6 (20/20). Ten subjects agreed to participate in the study. The mean age was 25 years (range 19 to 40).

Apparatus

Visual acuity (VA) was measured with an Amercan Optical projector chart. Refractive error was measured on a Canon RIO autorefractor. Lens thickness was measured with the Humphrey Ultrasonic Biometer model 810. This technique requires the instillation of topical anesthetic and application

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of a probe to the cornea. Because these procedures rnay affect vision and refraction, ultrasonic biomery was the last test performed. The subject was asked to view a specific letter on the VA chart at 3 rn in order to provide a constant accommodative stimulus during measurement of lens thickness.

Protocol

The testing consisted of two sessions. At each session, the subjects were seated in an empty lecture theater with a television of 600-mm screen size at a distance of 6 m. The subjects were instructed to watch the television for a period of 90 min. To encourage attentiveness and hence constant accommodation, the subjects were allowed to view material of their own choice.

The same test conditions and protocol were used at the two sessions, except that each subject wore his or her distance correction during one session and no correction at the other. The sessions were randomized with respect to wearing of spectacle correction. This was done to prevent any learning effects of VA testing as well eliminate examiner bias. In a. further attempt to eliminate bias, the subjects were misled as to the purpose of the experiment by the suggestion that they would be performing a comprehension test at the completion of the experiment.

Immediately after 90 min of television viewing, testing was conducted. Where spectacles were worn, these were removed just before entering the room in which measurements were made. This enabled masking of the observer as to whether or not spectacles had been worn. VA was measured first, followed by refractive error and, finally, lens thickness. The entire testing procedure was completed within 3 min.

The following questionnaire was presented to the subjects after the second session.

1. Do you find that after a period of spectacle wear, your vision seems worse without your spectacles than it would if you had not been wearing them?
2. Explain your observations please.
3. For how long does the reduction in acuity last?
4. Did you experience this phenomenon during this study?
5. Explain your observations please.

RESULTS

In response to the questionnaire, all 10 subjects reported regularly experiencing the phenomenon of increased blur after spectacle removal compared with vision after a period without spectacle wear. All 10 described the phenomenon as increased blur or poorer vision. Reported times of recovery ranged from 2 to 60 min with a mean (±SE) of 20 (±4.4) min.

VA values were converted from Snellen notation to logMAR-' values to allow parametric statistical evaluation. Refractive error values were converted to spherical equivalents. Binocular averages for each subject of all three parameters under test were used.

The VA at, the first and second sessions, regardless of correction, was compared to test for the existence of learning effects. These , results were indistinguishable statistically (paired t-test, $p = 0.34$), suggesting that learning effects were insignificant.

The uncorrected VA after the session with spectacle correction is plotted against the uncorrected VA after the session without spectacles in Fig. 1. For seven of the subjects, vision was better after the session without spectacle wear. For the other three, vision was equal. The mean (±.SE) logMAR difference of 0.039 (±0.015) between sessions was statistically significant (paired t-test, $p = 0.03$). This corresponds to 0.4 of a line or two letters.

Data for the refractive error after both sessions

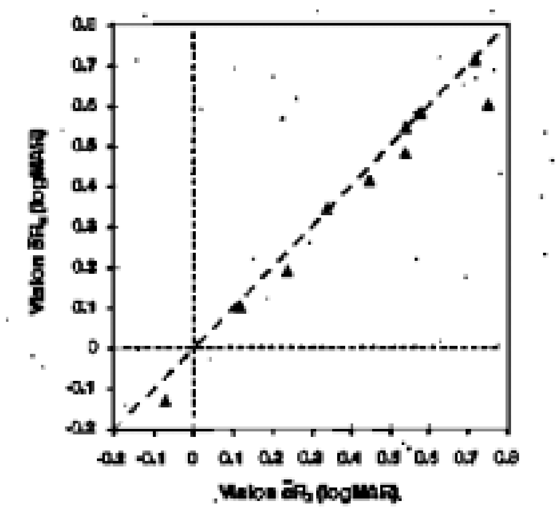

Figure 1. Plot of vision (logMAR) after a period without spectacle wear (š℞) vs. vision after a period with spectacle wear (č℞). The line represents equal acuities in each case.

TAi3LE 1. Visual acuity (VA), retraction, and lens thickness for each subject with (č℞) and without (š℞) correction.

	VA (logMAR)		Refraction (D)		Lens Thickness (mm)		Session at which ℞ Worn
	č℞	š℞	č℞	š℞	č℞	š℞	
Subject No.							
1	0.45	0.41	-1.78	-1.97	3.69	3.69	1st
2	0.12	0.10	-0.09	-0.12	3.51	3.53	1st
3	0.54	0.48	-1.25	-1.50	3.83	3.76	2nd
4	0.54	0.54	-0.93	-0.80	4.07	4.08	2nd
5	0.24	0.19	-1.43	-1.28	3.45	3.45	1st
6	0.58	0.58	-1.15	-1.18	3.24	3.50	1st
7	0.72	0.71	-1.75	-1.93	3.63	3.50	2nd
8	0.34	0.34	-0.69	-0.81	3.70	3.73	2nd
9	0.75	0.60	-1.84	-1.59	3.18	3.19	1st
10	-0.07	-0.13	-0.44	-0.15	3.60	3.58	2nd

are presented in Table 1. The mean (±SE) difference in refractive error of 10.002 (±0.061) D spherical equivalent was not statistically significant (paired t-test).

Data for lens thickness after both sessions are presented in Table 1. The mean (±SE) difference in lens thickness of 0.002 (±0.021) mm was not statistically significant (paired t-test).

Only eight of the subjects reported experiencing the. phenomenon during the test; some reported that it was as marked as usual, but three reported that it was less noticeable than usual. Subjective reports did not correspond well with changes in VA.

DISCUSSION

Due to the subtle nature of the changes observed in this experiment, the protocol deserves comment. Masking of the examiner was incomplete due to inadvertent cues such as indentation marks on the nose of the subject from the weight of the spectacles. The impact of this is likely to be minor because the three tests were -largely automatic in nature, offering little scope for examiner-induced bias. It was also impossible to maintain subject naivety with respect to state of visual correction. Several subjects reported at the conclusion of the experiment that this cue hinted at the nature of the experiments. Randomization was successful because there were no significant learning effects influencing the VA results.

The time course of recovery suggested by the subjects (mean ±SE = 20 ± 4.4 min) indicates that t'iere was probably sufficient time for the testing o be performed before recovery was completed (testing time, 3 min). However, this method of determining recovery time could not be considered reliable.

We have verified the clinical impression that myopes of low degree not only report, but indeed experience, a decrease in uncorrected vision after distance viewing with spectacle wear compared to vision after a prolonged period without correction. To our knowledge, this phenomenon has not been experimentally demonstrated previously.

We considered three theories to explain the phenomenon. First, wearing of spectacles may lead to a different accommodative tonus than a period without spectacle wear. The "corrected' myopic eye, although not considered to be overcorrected, may be in a partially accommodated state. It is clear that moderate periods of accommodation result in an increase of accommodative tonus.[3-6] On removal of the spectacles, this tonus may take some time to release, resulting in decreased acuity.

The second theory is sensory adaptation to blur. A high level of contrast at all spatial frequencies exists for the corrected eye. The visual system may adapt to these high levels of contrast at all spatial frequencies, but notably those at the high end. The introduction of blur would lead to a loss of contrast and the visual channels may not be sufficiently sensitive to detect fine detail. As adaptation to the lower levels of contrast at high spatial frequencies occurs, VA would improve.

The third explanation has a psychological basis. Comparing stimuli that are separated temporally, such as the two instances of uncorrected vision witnessed in this experiment, is a difficult task and the criterion for blur may change. Uncorrected vision after spectacle removal can only be compared directly with corrected vision and will be considered less satisfactory because this yardstick is dramatically better. This may be the basis for the claimed reduction in vision. An alternative reason for a psychological basis is a preconceived idea that spectacles “weaken the eyes."

The finding of a slight decrease in vision in the absence of a change in refraction or lens thickness suggests that the sensory adaptation theory is the appropriate model. However, none of the other theories can be totally discarded.

According to the accommodative theory, the observed change in VA would require a small change in refractive error to account for it. The methods used in this experiment for measuring refraction and crystalline lens parameters may be insensitive to the small changes required to induce the visual decrement observed. Systematic errors arising from the autorefractor or the ultrasonic biometer are of little consequence to the results of this study because relative results were compared. Confidence limits (95%) for changes in refractive error were calculated to be approximately ±0.12 D. Although the relation between refractive error and VA at very low levels is unclear,' changes in refractive error of any consequence should be detectable by our technique. Confidence limits (95%) for changes in lens .thickness were calculated to be approximately ± 0.04 mm, corresponding to a change of approximately 0.50 D in lens power.[9] Consequently, changes in lens power of up to 0.50 D may be undetected. Perhaps Purkinje image photography, as suggested by Van Veen and Goss,[10] would be a sufficiently accurate method of analysing lens parameter changes to use in repeating this experiment.

The psychological theory would be accepted where patient reports of decreased vision are unaccompanied by a measurable loss of VA or change in refraction. A significant reduction of VA was observed, suggesting that this theory is incorrect; however, the vision reduction was minimal, whereas the subjective reports suggest that a reduction in vision of a greater amount has occurred. Thus, the effect may be explained by a combination of the sensory adaptation and psychological theories. Further research, in which scaling of the subjective decrease of vision is recorded, would he required to verify the existence of a psychological perception of vision loss.

Other theories might be proposed to explain the phenomenon. Alteration to the corneal curvature may occur from variation of the interpalpebral aperture as different eyelid postures are adopted with and without spectacles; certainly, lid pressure during reading has been shown to result in altered corneal shape[11] Alternatively, adaptation of eyelid posture in itself and its effects on depth of focus may produce the effect. Repeating the study using a corneal topographic system and videotaping subjects' eyelid postures would enable the influence of these factors. to be elucidated.

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